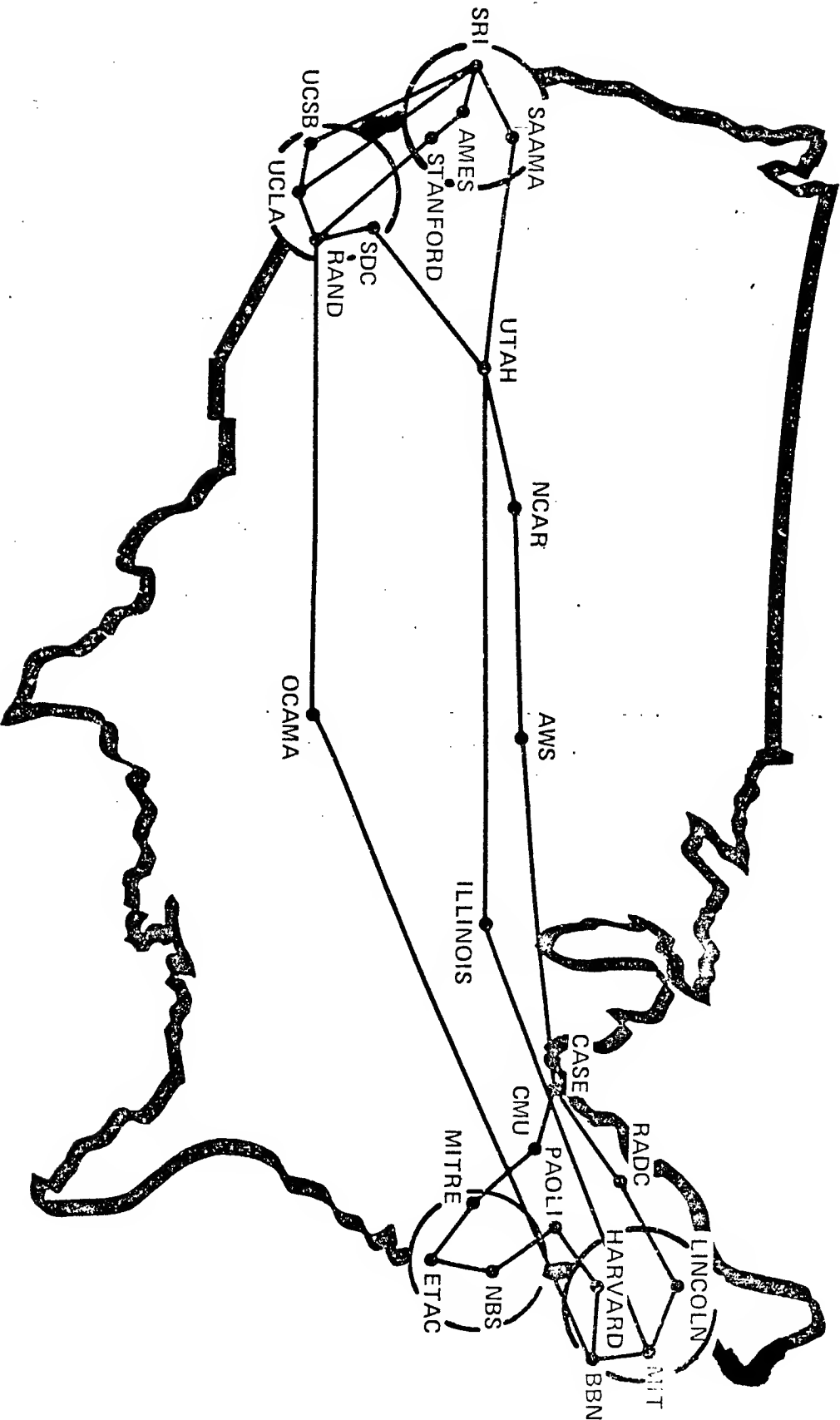


\$37K/Node/Yr

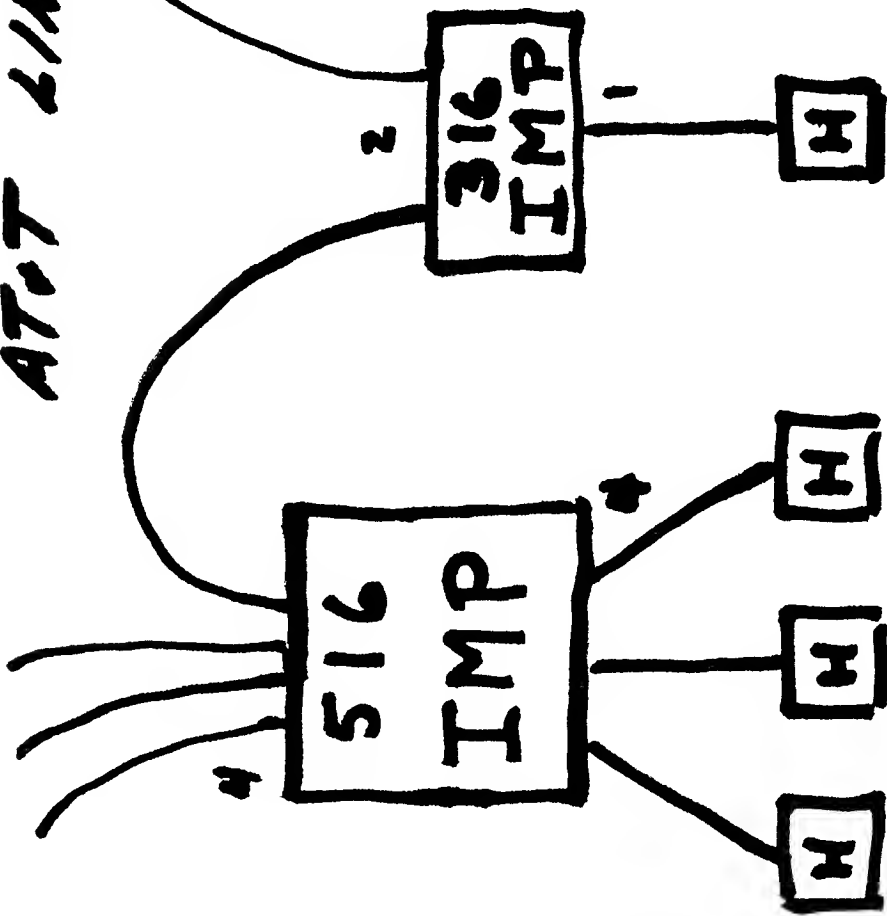
10.4 KB/Node

23 Nodes

ARPANET MARCH 1972



AT&T LINES

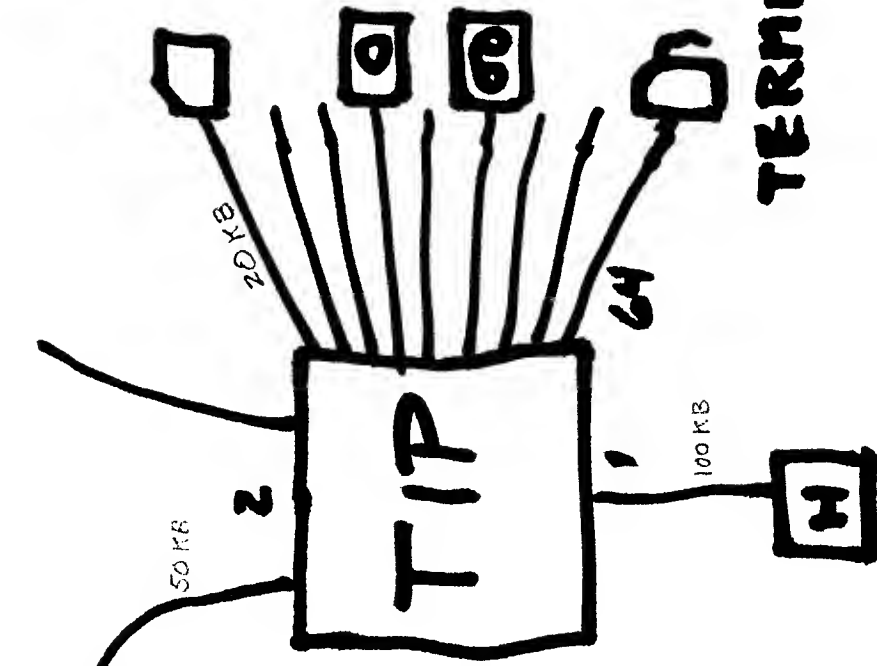


HOSTS

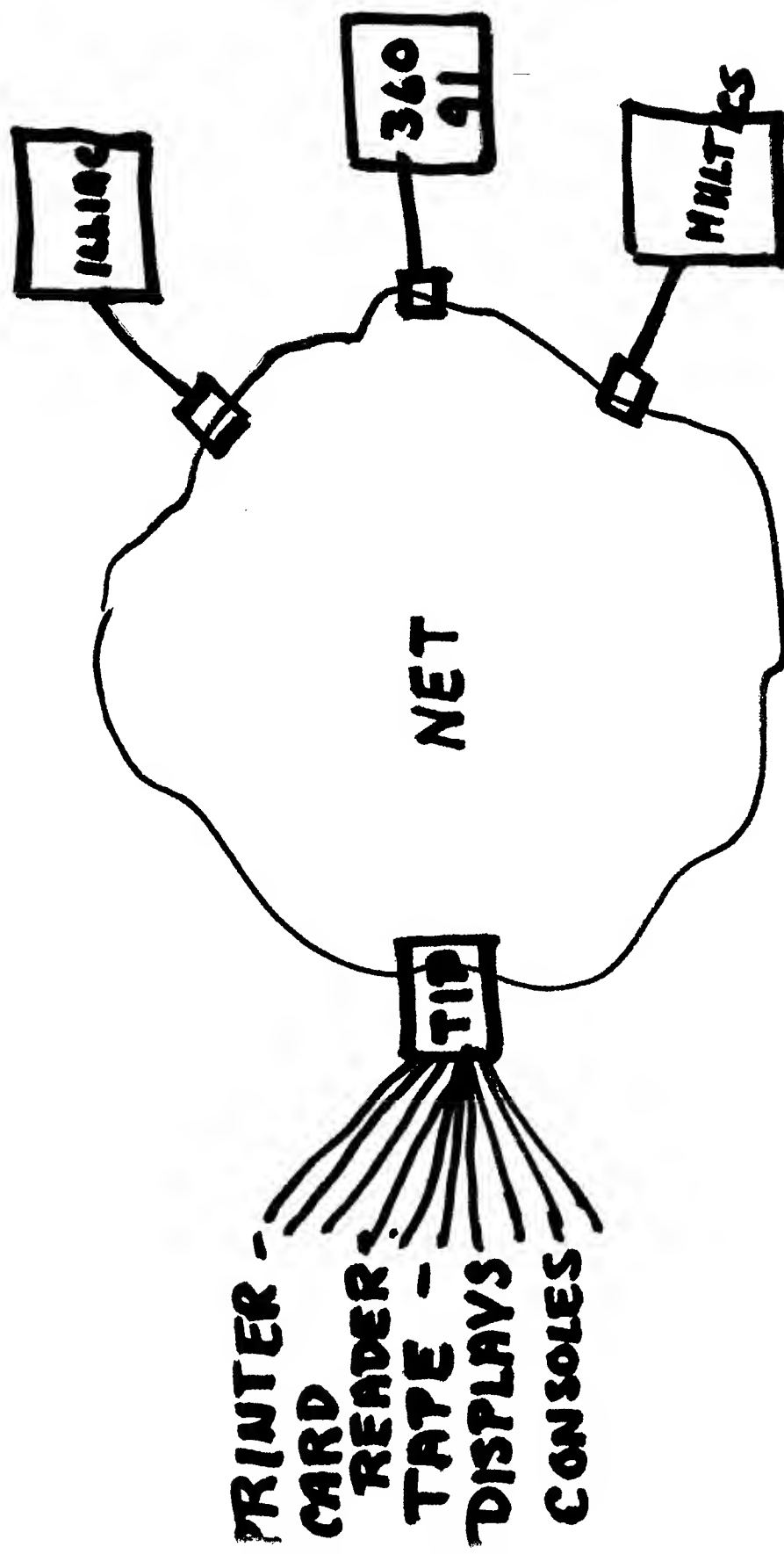
\$100K

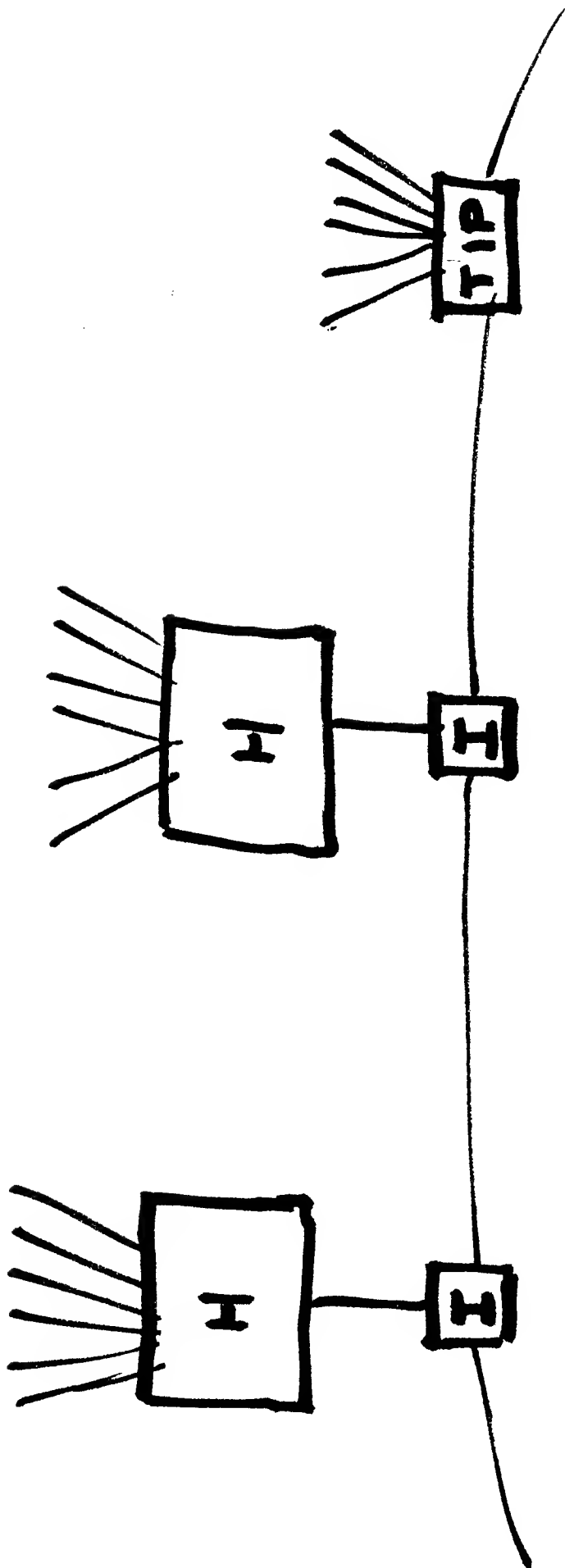
\$50K

\$100K



TERMINALS

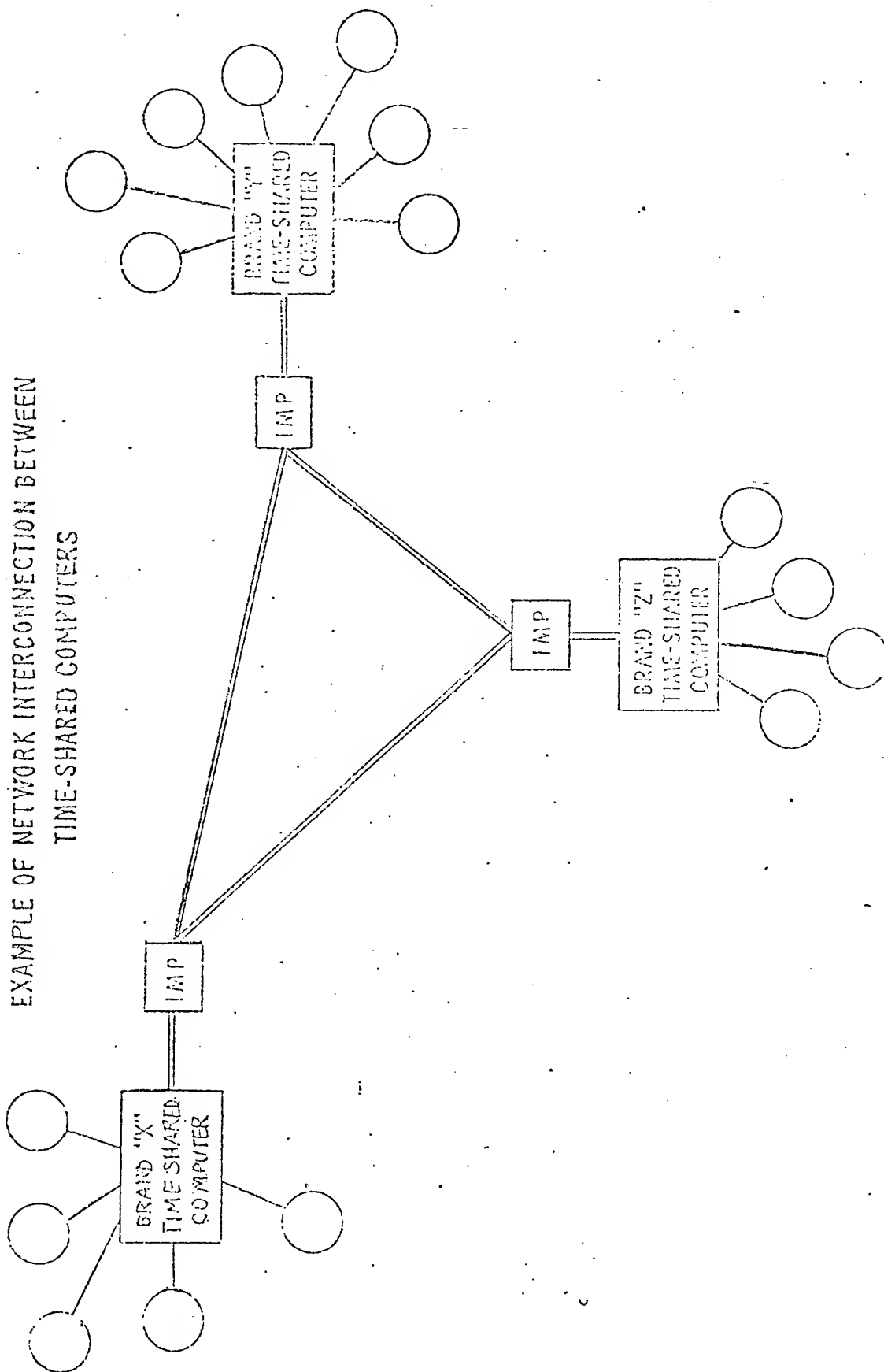






**PERIPHERALS
& CONSOLES**

EXAMPLE OF NETWORK INTERCONNECTION BETWEEN
TIME-SHARED COMPUTERS



INTERFACE MESSAGE PROCESSOR
(IMP)

50 KB
LEASED
LINES

AT&T
DATA
SETS

303

Line
Channel

303

Line
Channel

303

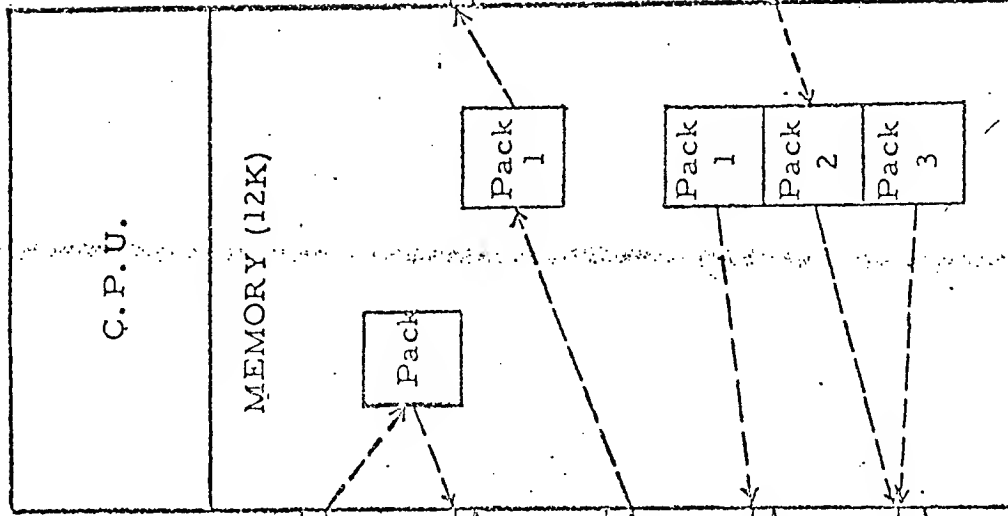
Line
Channel

303

Line
Channel

303

Line
Channel



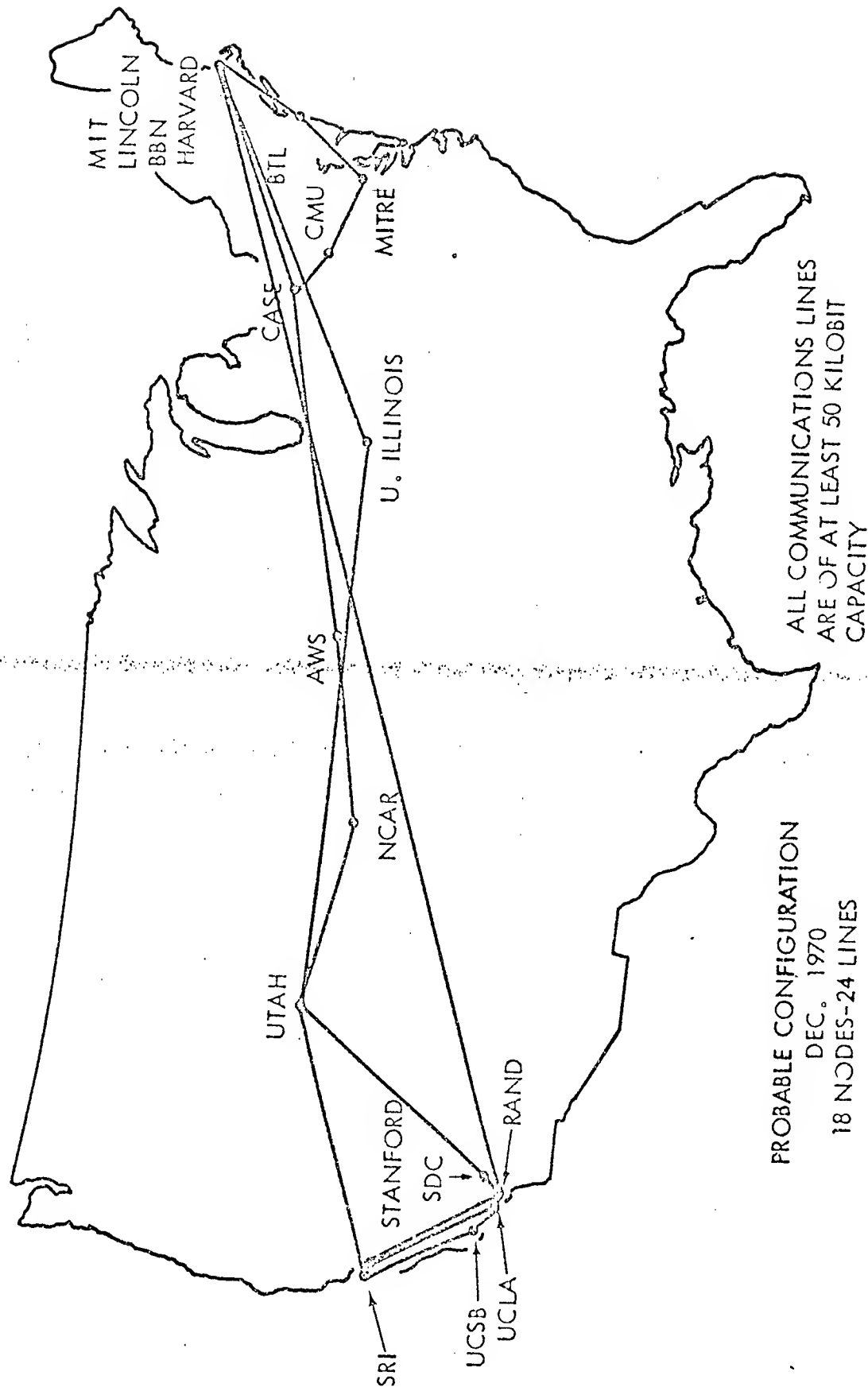
Host
Channel

DIGITAL LINKS
TO HOSTS

Host
Channel

HONEYWELL 516

ARPA COMPUTER NETWORK



ARPA NETWORK INITIAL TOPOLOGY

\$49 K per node per year
16 KB per node

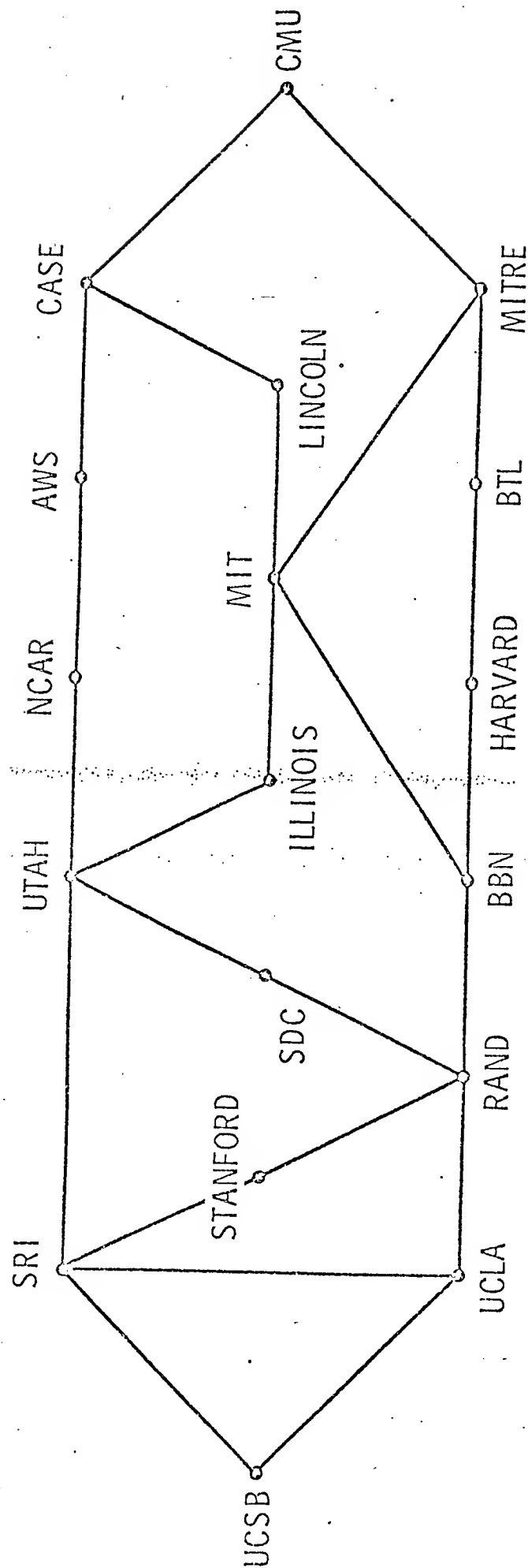


FIGURE 1

ARPA NETWORK EXPANDED TOPOLOGY

\$59 K per node per year
23 KB per node

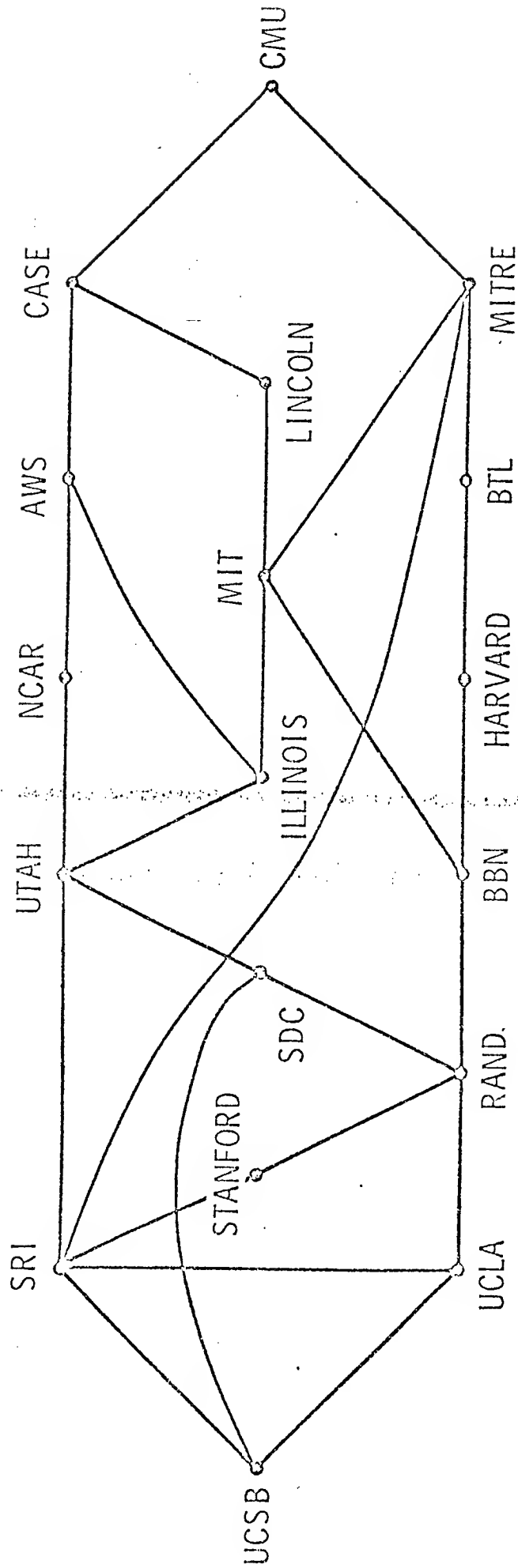


FIGURE 2

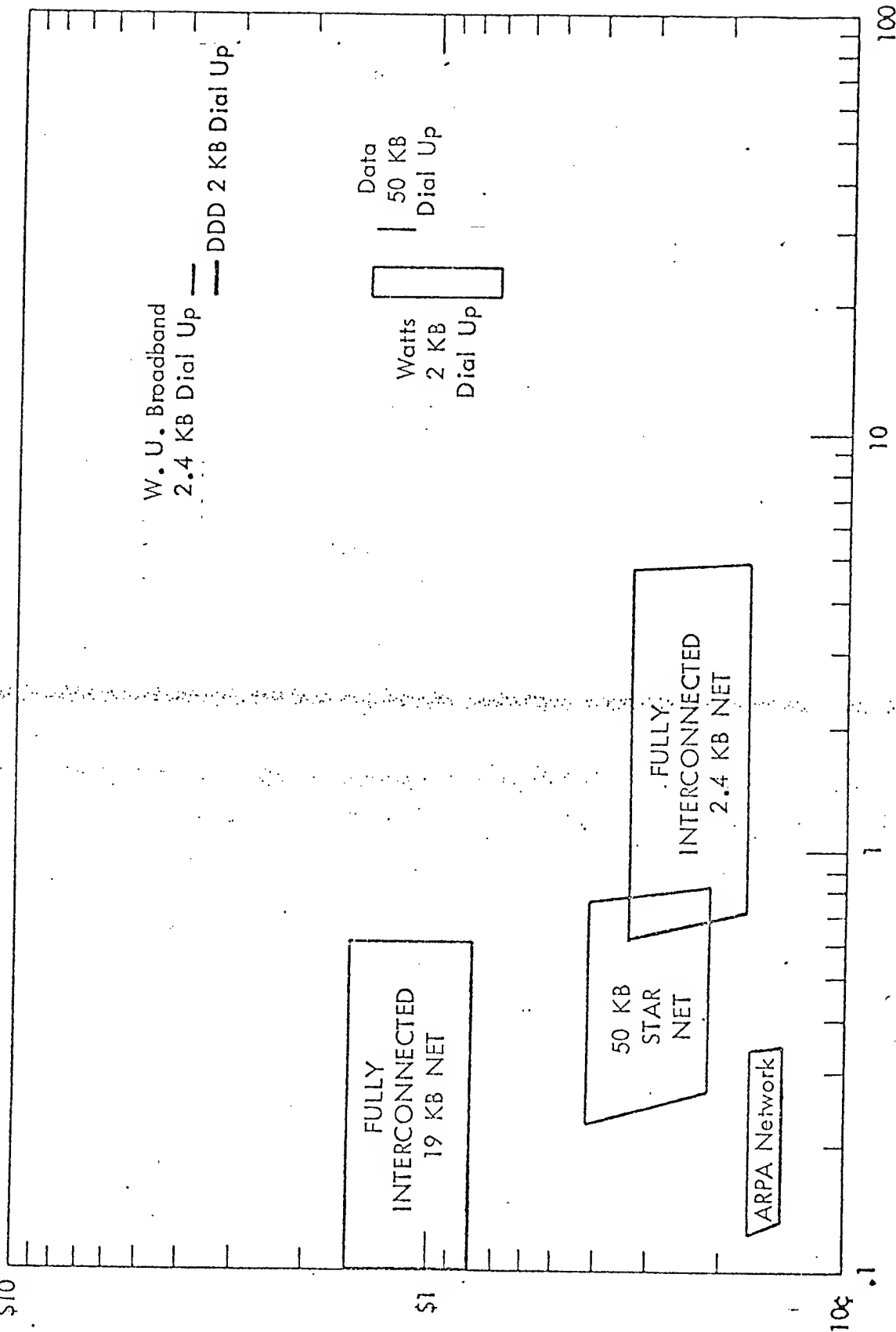
COST OF TRANSMITTING ONE MEGABIT OF INFORMATION A DISTANCE OF 1400 MILES VIA VARIOUS COMMUNICATION MEDIA

MEDIA	COST PER MEGABIT	BLOCK SIZE
TELEGRAM	\$3300.00	3K bits
NIGHT LETTER	565.00	3K
TELEX	204.00	-
AUTODIN	8.20	30K
DIRECT DISTANCE DIALING	3.45	-
LETTER	3.30	30K
WATS	1.54	-
DATA-50	.47	-
ARPA NETWORK	.30	1K
MAIL COMPUTER TAPE	.034	100 million bits

COST VS. DELAY

FOR POTENTIAL 20 NODE NETWORK DESIGNS

Cost Per Megabit for
Node - Pair Average
Rates of .5 to 1 KB



Delay in Seconds for Messages 1 to 10 Kilobits Long

FIGURE 3

EFFECTIVE BANDWIDTH VS. BLOCK SIZE

TWENTY NODE NETWORK

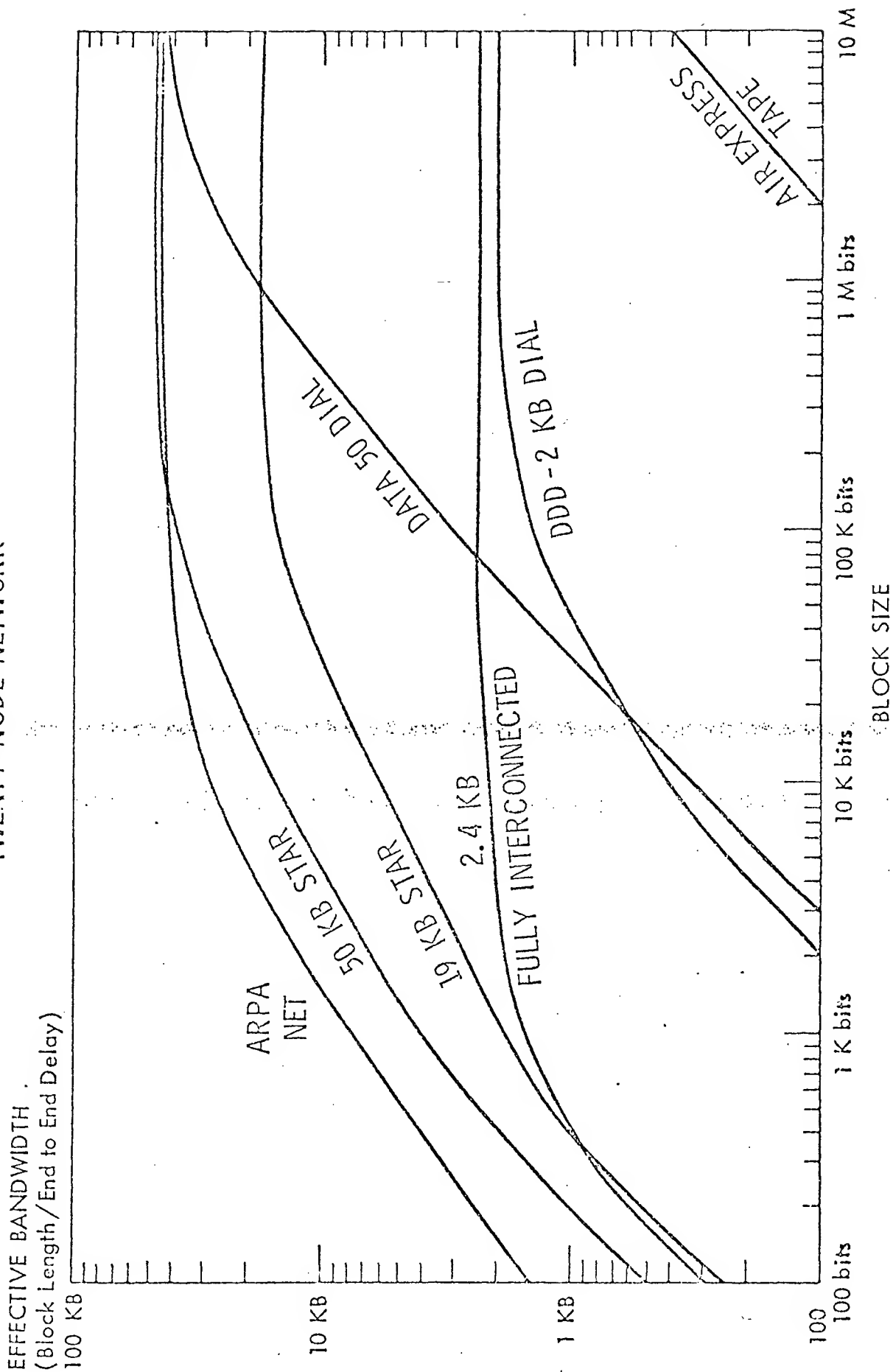


FIGURE 4

ARPANET

Current Net: 16 nodes, 24 host computers, Lines-\$50K/node/yr
At end 1971: 20 nodes, 30 host computers, Lines-\$40K/node/yr

Communication Service

Response- .1 sec avg, line of text, any node to any node
.3 sec avg, page of text (1000 characters)
12 sec, photograph (1 M bits)(bulk rate=80 KB)
Capacity- IMP throughput capability = 750 kilobits/sec
Current net permits 15KB/node average input rate
Capacities from 2-60 KB can be designed for
Reliability-Undetected bit error rate: 10^{12} (under 1 message/yr)
Service Uptime: 95% (Based on current IMP failure rate
from all causes of 2% and line failure rate of 2%)
Cost- \$3-6K/mo for lines, leased IMPS and maint.
ARPANET (1972)-\$6K/mo (10 KB/node)
Low capacity, large net-\$3K/mo (3KB/node)
Incremental cost for additional capacity: 30¢/megabit
Comparison: AUTODIN 2. 4KB termination-\$11K/mo

Resource Sharing

Protocol - System to system protocol standardized-Aug 1970
Network Control Program implementing above
complete as of Jul 71, at all nodes. Effort-
6-man-mo./site
Higher level protocols for graphics, etc. being
designed
Typical Uses - Direct use of locally unavailable hardware
- Reprogramming for new machine(avail. in net)
- Subroutine use of faster remote hardware(FFT)
- Non duplicative access to large data base
- Remote execution of software (send data)
- Cooperative editing, library services
- Conferencing, real time or not
- Mail (10 times cheaper for letters)

Development Level

Communication System: Solid, current capability transferable.
Computer-computer resource sharing: New protocol by 1972, then anyone can join.
Multi-computer tasks: Problems like retrieval from widely distributed data bases
will require many years of research.

Program Funding-Prior - \$5.3M, FY71 - \$5.4M, FY 72 - \$7.6M, FY 73 - \$7.6M

HISTORY

BBN contract 1/69

TEST NET

1. UCLA	9/69
2. SRI	10/69
3. UCSB	11/69
4. Utah	12/69

IPT NET

5. BBN	4/70
6. MIT	4/70
7. Rand	5/70
8. SDC	6/70
9. Harvard	6/70
10. Lincoln	7/70
11. Stanford	7/70
12. Carnegie	11/70
13. Case	12/70
14. Illinois	1/71
15. Paoli	2/71

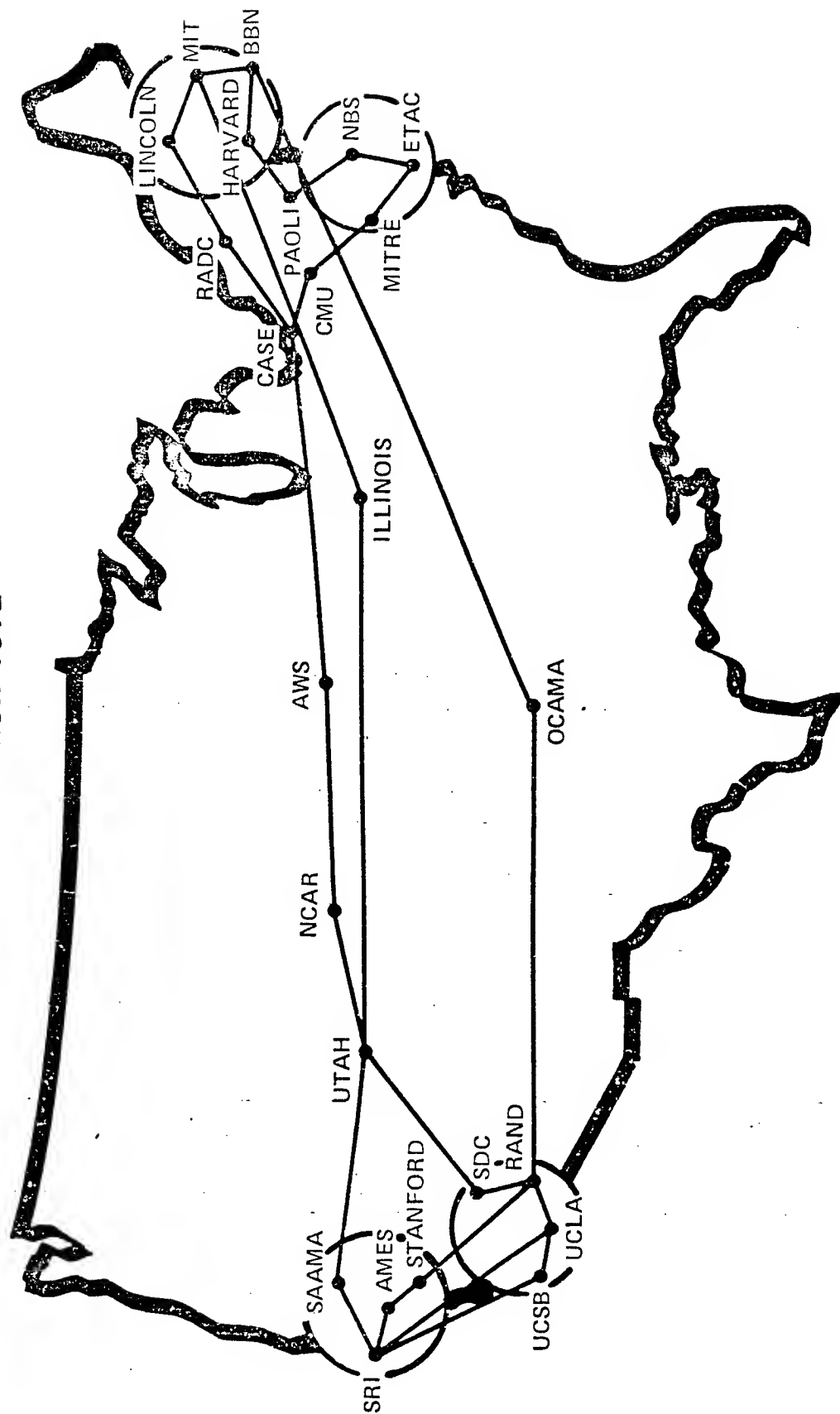
USER TIPS

16. NASA	8/71
17. Mitre	9/71
18. RADC*	10/71
19. NBS*	11/71
20. ETAC+	12/71
21. USC	3/72
22. TINKER+	3/72
23. McCLELLEN+	3/72
24. NCAR	3/72
25. GWCT	3/72

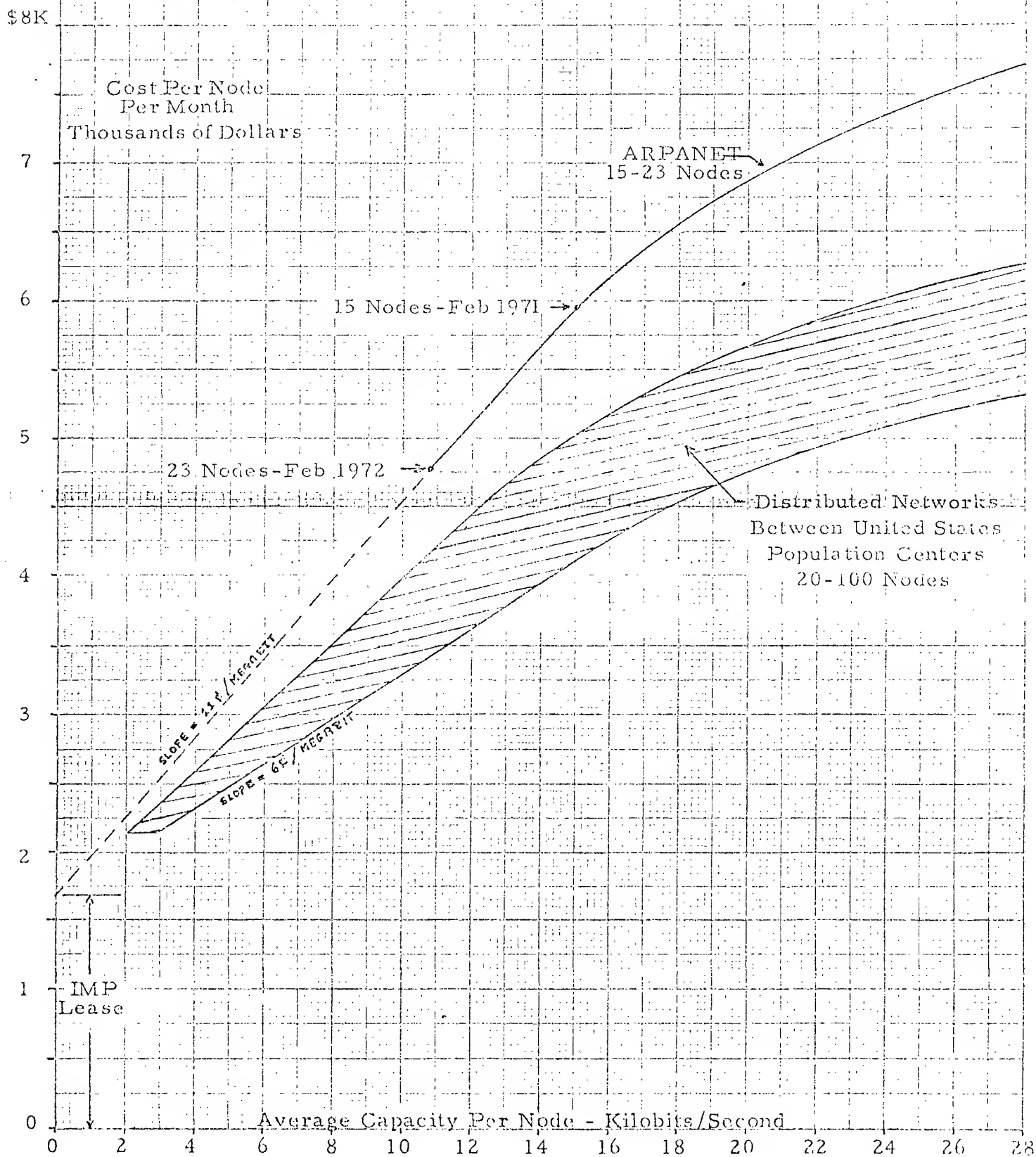
*Non-ARPA funded

+AF funding in FY 73

ARPANET
MARCH 1972



ARPA NETWORK - COST VS CAPACITY



THE ARPA NETWORK

August 1972

